Space Weather Technical Forecast

Issued on Sunday, 19 December 2021 at 00:41 Local

This technical forecast provides a four-day assessment of space weather events. The probabilities stated below are for reaching or exceeding the given levels. For more information about space weather impacts please see the Met Office Space Weather Scales https://www.metoffice.gov.uk/weather/learn-about/space-weather/uk-scales

Space Weather Forecast Headline: Daily Chance of M-class flares. Slight Chance of G1 by midweek UTC.

Analysis of Space Weather Activity over past 24 hours

Solar Activity: Solar activity has been Low in the past 24 hours, with the X-ray trace at GOES 16 dominated by a long-period C6.3 X-ray flare that peaked at 18/1803UTC. This flare emanated from near the southeastern limb - potentially from a new unnumbered sunspot region here - of which there may be up to three in close proximity. A Coronal Mass Ejection (CME) was tied to this event, and while this has yet to be analysed, Earth-based effects are considered very unlikely, with the emission directed east of, and below the Earth in the track of its orbit. No other CMEs were in evidence in available imagery.

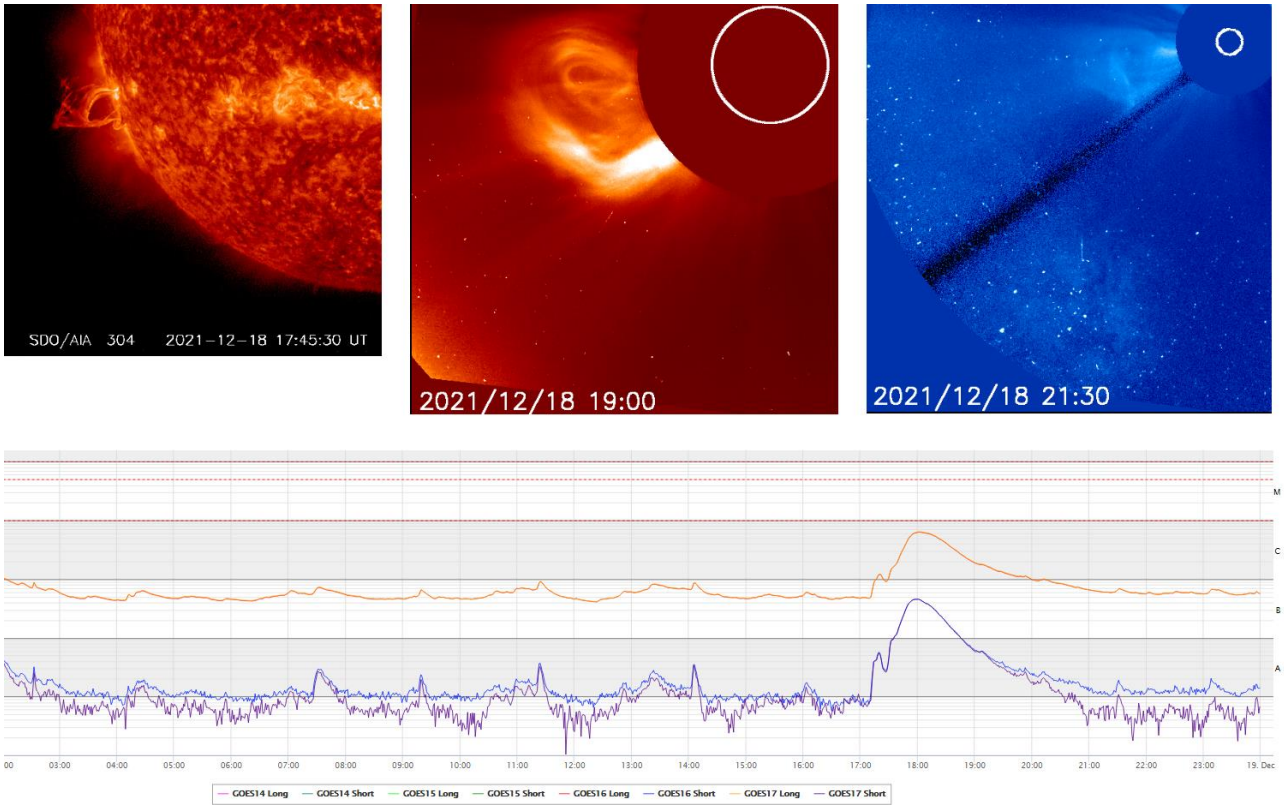

Figure 0: AIA 304, Lasco C2 and Lasco C3 imagery of an eastern limb C6.3 flare and CME. While not liekly to affect Earth, this event perhaps hints at a more active disc in the coming days as this area more fully rotates onto the facing side.

There are currently six numbered sunspot regions on the visible disc, as well as the aforementioned three possible new regions in the southeastern quadrant, and a spotless plage in

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the northeast. Of these sunspots, AR2907 perhaps showed the most dynamism in the period, with growth and proliferation in its high latitude trailer, finishing the period as a Dai/Beta. 2908 to its immediate east showed areal decay and spreading, ending the 24 hours a Dao/Beta. Both the western hemisphere spots decayed to unipolar Axx groups, while 2911 and 2909 also showed general decay to end as Beta Cso and Dso respectively.

Solar Wind / Geomagnetic Activity: Solar winds, as measured by the DSCOVR satellite at L1, have followed a slow regime through the 24-hour period. The solar wind speed ranged between 325 and 375km/s, while the density remained within mid-single figures ppcc. The IMF peaked at 5nT, with the north-south component varying between +4/-3nT. The phi angle was mainly negative (towards the sun), but with a neutral or positive phase between 18/0600 and 1200UTC.
The net effect of these solar wind measures was provisionally Quiet Kp throughout, peaking at Kp '2-' in the 18-21UTC interval.

Energetic Particles / Solar Radiation: The high energy proton flux (greater than 10 MeV) remained at Background levels.

The high energy electron flux (greater than 2 MeV) was at mainly Background levels, with the associated 24-hour integrated fluence well below the Active threshold. A fluence of 2.77e6 was observed at 19/0000UTC.

Four-Day Space Weather Forecast Summary

Solar Activity: Solar activity is expected to continue mainly Low, with the Chance (30%) of isolated M-class flares, and a Slight (5%) Chance of an X-class flare.

Solar Wind / Geomagnetic Activity: No CMEs feature in the current forecast period. Initially Quiet geomagnetic conditions should give way to a chance of some influence from the small CH36 later in the UTC weekend, perhaps peaking at Active, before reverting to Quiet once again. There is then a possible low confidence late peak in activity possible from CH35, perhaps most likely from Tuesday 21 December, which is signposted by a Slight Chance of G1/Minor Storm, peaking midweek.

Energetic Particles / Solar Radiation: The high energy (greater than 10 MeV) proton flux is expected to remain at Background levels, although with a slight increasing risk as the active regions transit towards the western solar hemisphere.

The high energy (greater than 2 MeV) electron flux, as observed by GOES-16, is expected to be at Background to Moderate levels, perhaps with a low confidence slight rising trend later in the period - the result of a much-changed disc rendering persistence methods less useful. Despite this, the associated fluence is expected to remain below the Active threshold.

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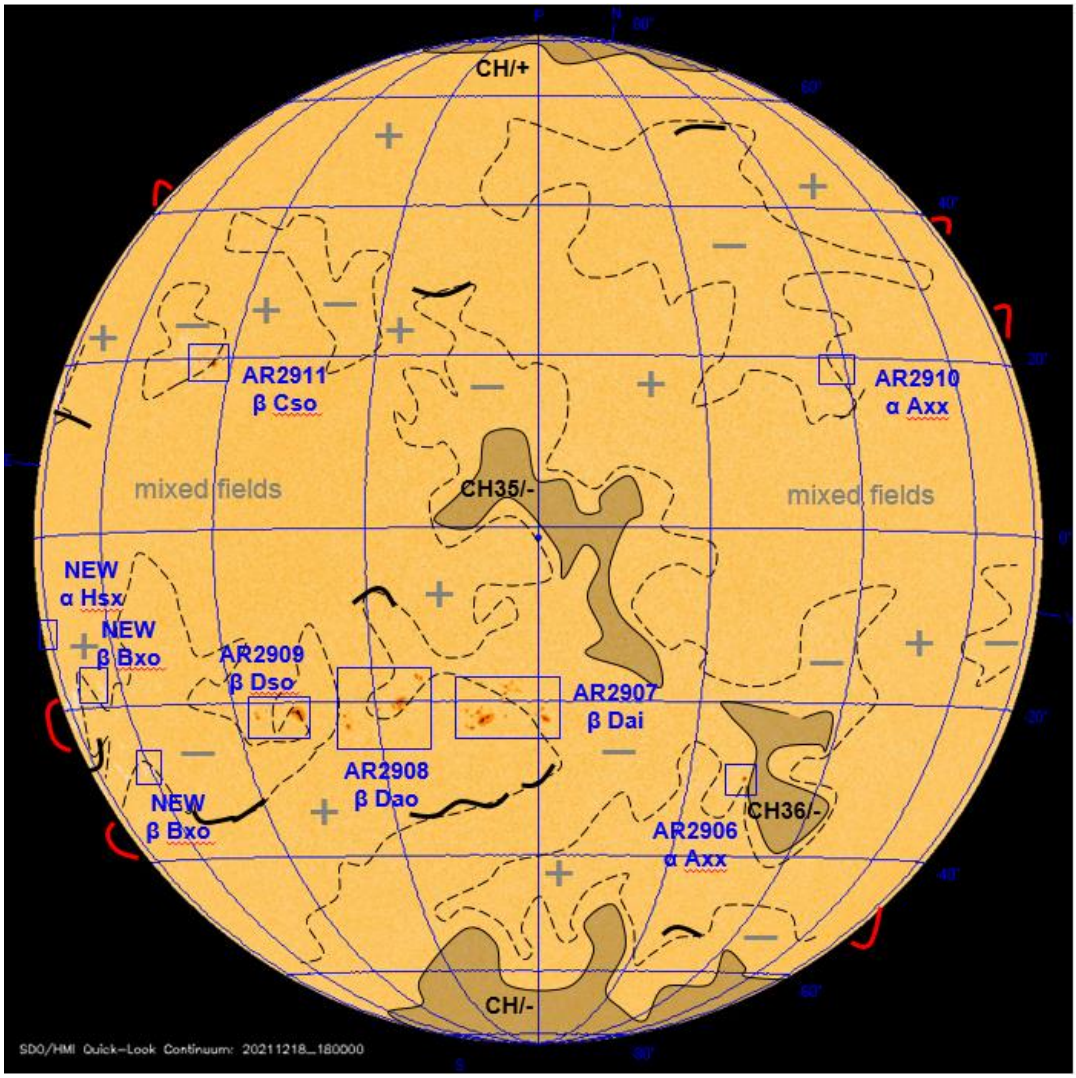
Figure 1. Solar Analysis Valid 18/1800UTC.



Key: Filament ___ , Prominence ___ , Magnetic Field Line - - - , Polarity +/-, Coronal Holes: Grey shaded area CHxx +/-, Sunspot groups 25xx - Mt Wilson α-β-βγ-βγδ and Zurich-McIntosh Axx etc.

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Geomagnetic Storms:

No Earth-directed CMEs feature in this forecast.

The coronal hole forecast for the whole period is of lower than average confidence, for being much changed compared with November.

Earth is currently sampling a slow solar wind, however recent STEREO A PLASTIC data suggests a possible modest coronal hole-like enhancement to near 500km/s is due inside 24 hours, which may be the result of the much-reduced CH36/-, which is a vestigial remnant of a much larger coronal hole from 27 days ago (reaching the upper-600s of km/s). The emergence of a train of sunspot regions in this location appears to have largely closed the coronal hole, but STEREO A data perhaps implies that it survives in some form.

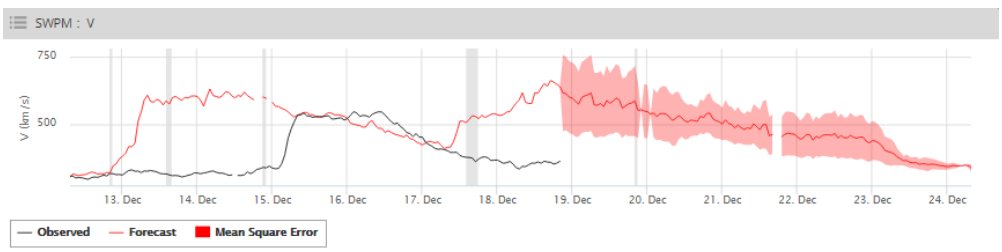
In a mainly Quiet forecast, there is now considered to be a Chance of some Active intervals later in the UTC weekend, perhaps also lasting into the start of the working week. CH35 may also make an appearance later in the four days, with this aspect especially uncertain for having no measurement of the speed available. A peak Slight Chance of G1/Minor Storm is proposed, although with this being the winter solstice any effect will probably be muted.

Geo-Magnetic Storm Probability (Exceedance)	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Minor or Moderate	G1 to G2	No	1	1	5	10
Strong	G3	No	1	1	1	1
Severe	G4	No	1	1	1	1
Extreme	G5	No	1	1	1	1

Geomagnetic Activity - Earthbound Coronal Mass Ejections

Nil.

Figure 2: MOSWOC SWPM, showing a near anti-phase relationship in the solar wind speed. CH32/- was late and low magnitude relative to last pass, with CH36 expected to be similar in the next 24 hours. CH35 may then arrive towards midweek, with speeds probably peaking at this time, although perhaps not to the degree shown.



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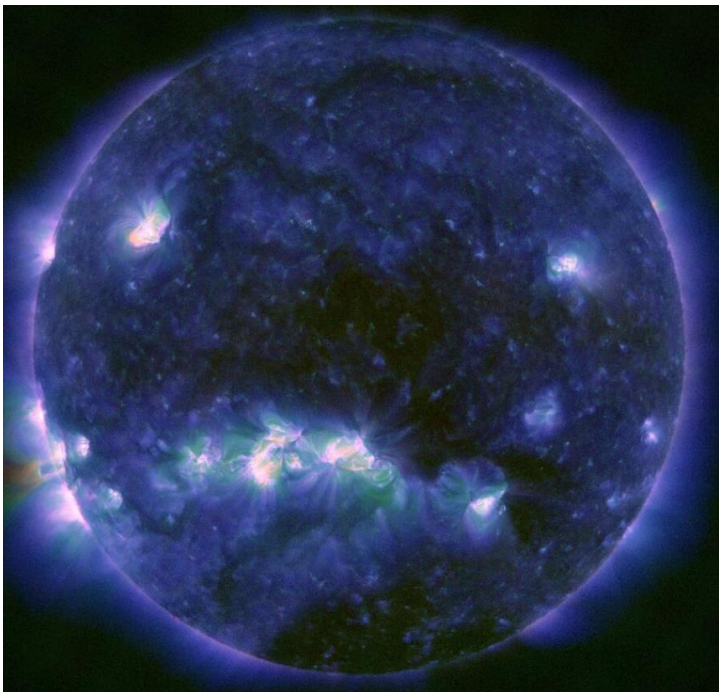
Radio Blackouts - X-Ray Flares:

The current Earth-facing disc is replete with sunspots at present, especially the eastern solar hemisphere, with the southeast most stark in terms of being strongly magnetically polarised. The overall trend on the Earth-facing side has been towards stabilisation of the current sunspots, with 2907 the main group to run counter to this with some proliferation visible later in the 24 hours in its high latitude trailing spots. While the western solar hemisphere sunspot groups 2910 and 2906 faded, up to three new sunspot regions were seen to arrive in the east, all in the southeast. Adding to this, a plage in the northeast may yet reveal sunspots once the viewing angle becomes more favourable.

All considered, while the longer term incumbents have steadied on the disc, the sheer weight of numbers of regions arriving in the east is felt likely to be able to compensate for any reducing risk of flares, with a flat daily Chance of M-class flares and a Slight Chance of X-class maintained. It remains the case that C-class flares are Expected throughout, with a 90% daily risk.

X Ray Flares Probability	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	R1-R2 M Class	No	30	30	30	30
Very Active	R3 to R5 X Class	No	5	5	5	5

Figure 3: AIA composite satellite image from 18/2300UTC showing potential active regions in 335, 193 and 094 Angstroms. Note especially the concentration of these in the southeastern quadrant.



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Solar Radiation Storms - (High Energy Protons):

The high energy proton flux (greater than 10 MeV) as observed by GOES-16 is currently expected to remain at Background levels.

Increasing sunspot activity may warrant a slight increase in the chance of S1 radiation storms over the next few days, though at present the most significant active regions are in the eastern hemisphere of the solar disc.

Radiation Storms Probability (Exceedance)	Level (cm^{-2} sr^{-1} s^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	**≥ S1**	No	2	2	5	5
Very Active	**≥ S3 ***	No	1	1	1	1
* S3 ≥ 10 MeV ≥ 1000 pfu and / or ≥ 50 MeV ≥ 10 pfu. (pfu = $cm^{-2}sr^{-1}s^{-1}$)						

High Energy Electrons Event (≥ 2MeV):

The high energy (greater than 2 MeV) electron flux, as observed by GOES-16, is currently at Background to Moderate levels, and is expected to remain as such in the near term. The fact that coronal holes potentially due in the period are much-changed from last rotation means that persistence forecasting is not expected to provide a useful steer in this case. Recent STEREO A MAG and PLASTIC data has become very intermittent, but perhaps suggests a minor high speed stream is possible at Earth in the next 24 hours, probably that from the remnant coronal hole 36. This is felt unlikely to significantly alter current flux levels, with speeds of around 500km/s observed. A slight uptick in probabilities is therefore proposed, before the likely larger CH35/- perhaps arrives later in the four days (perhaps Tuesday 21 December), with the risk of Active fluence likely to peak in the middle of the forthcoming working week UTC as a result.

GEO Electron Environment Probability (Exceedance)	Level (cm^{-2} sr^{-1} day^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	**≥ 2 MeV ≥ $1x10^8$**	No	1	1	5	20
Very Active	**≥ 2 MeV ≥ $1x10^9$**	No	1	1	1	1

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